Early Weight Bearing Versus Traditional Physical Therapy Program in Management of Ankle Sprain

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ABSTRACT

Inversion ankle sprains comprise a high percentage of all orthopaedic injuries. Rehabilitation of the patient with lower extreminty dysfunction is frequently limited to open kinetic chain exercise due to pain, swelling and weakness in weight bearing positions. This study was designed to assess the effect of early use of a newly designed of unloading technique of a controlled reduction in body weight during activites in comparison the effeciency of the traditional physical therapy program after acute grade I and grade II inversion ankle sprain. Forty patients were included in the study, and were randomlley divided into two groups. The first group under went the traditional exercise program and the second group followed the early weight bearing program. Subjects were tested and pre and post tratment program for the ankle range of motion, pain, and swelling. The results showed that disappearance of pain, swelling and return to normal range of motion in group two by the end of fifth week. This means that return to function can be achieved in a short period by exercise that is performed with a gradual increase in pain-free weight bearing capacity.

Key words: *Ankle joint , unloading, rehabilitation, pain-free weight bearing.*

INTRODUCTION

Ankle sprains are among the most common injuries among physically active people and most frequently affect the lateral ligamentous complex[12]. Damage of lateral structures often results in disability which can be found in as many as 33% to 42% of individuals who have experience injury to lateral collateral ligament[3]. The most common complications following ankle sprains are mechanical and functional instabilities. Mechanical instability is abnormally increased mobility, and indicates a lesion of the passive stabilizers of the ankle primary the ligaments. Functional instability is the most common residual symptom following ankle sprains and seems to occur in 17 to 85 percent of the patients; many causes have been demonstrated for functional instability including, peroneal weakness, mechanical instability, and proprioceptor damage[23]. There are many treatment programs in use today for ankle sprains some advocated non-weight bearing for three weeks. Other advocated ice application, compression, crutches, strapping gel cast, range of motion exercises, non steroidal anti-inflammatory drugs and proprioceptive neuromuscolar facilitation; with mean treatment time of 17 days[21]. The most traditional factor associated with functional instability of the ankle is anatomic laxity due to an acute sprain of the anterior talofibular and clacaneofibular ligaments[19]. Trauma to mechanoreceptors of the lateral ligaments can produce a proprioceptive deficit in the ankle. The decrease in sensory input from these receptors may lead to faulty ankle joint positioning and could increase the probability of re-injury[12]. The goal of treatment and rehabilitation of all ankle injuries is to prevent chronic functional instability[22]. Lateral ankle sprains, although both immobilization and early mobilization prevent late residual symptoms and ankle instability, early mobilization has the advantage of early return to function, less muscle atrophy, and better mobility. It allows earlier return to work and may be more comfortable for patients than immobilization[10]. Early post injury weight bearing can improve the healing and strength of damaged ligaments, by increasing collagen formation and reducing adhesions; improved tissue nutrition, minimized muscle wasting, and minimal loss of strength are also benefits of early weight bearing[14]. Recently the physical therapy rehabilitation has been redirected towards functional training during lower extremity weight bearing activities because it is very beneficial to apply tensile strength on the ligaments to promote good healing and

remodeling of the healed tissues and this was difficult till invention of this device which encourage the patient to perform the exercises from standing position, but with partial weight bearing to the limits of his pain[11]. Weight bearing is a vital stimulus for maintenance of muscloskeletal function and observed that maximal voluntary knee extensor strength is reduced after a period without weight bearing activity in healthy humans[2]. Reduction in skeletal muscle mass and strength have been shown after space flight or simulated micro gravity, i.e. bed rest, in humans[1]. During immobilization skeletal muscle undergoes decreases in size and strength with atrophic and degenerative changes in slow-twitch Muscle fibers[4]. After space flight there were affection at the number of neural elements of neuromotor function, maximum torque of the leg, atrophy and loss of soleus mass, decrease in strength, decrease in muscle fiber and capillaries[9]. It was found that after bed rest or casting there is loss of muscle strength and its size[20]. It is believed that increase weight bearing on the involved limb, promote symmetry and facilitate weight shifting while controlling posture[16]. This study is an attempt to investigate the effectiveness of new treatment approach that include the mechanical reduction of gravity with pain free lower extremity weight bearing by reducing force on injured tissues.

PATIENTS AND METHODS

Patients

Forty volunteers subjects from both sexes suffering from unilateral ankle sprain admitted in the emergency department of ortheopaedics at Imbaba General Hospital within 48 hours of an acute injury of grade I and grade II of the lateral ankle ligaments. Their ages ranged from 19-38 years. Weight ranged from 55-83 kg. Twenty subjects were randomly assigned for traditional program of rehabilitation of lateral ankle sprain group I and twenty subjects waere randomly assigned for the early wieght bearing program group II.

Inclusion Criteria

1- Unilateral ankle sprain.
2- First and second degree of ankle sprain.
3- Within 48 hours of an acute injury.
4- No other injuries at the lower limbs.

Exclusion Criteria

Instrumentations

1- Visual analog scale.
2- An ordinary flexible measuring tape with length 150 cm, utilized to obtain the meaurements of each subjects in both ankles (normal and injured) for swelling.
3- Standard plastic manual goniometer.

The goniometer had two arms, with a scale marked in 1- degree the goniometer was used to measure the total active ROM of the ankle joint in dorsiflexion, planterflexion, eversion and inversion bilaterally.

4- Biodex unweghing system

Biodex medical system, Inc. Brookhven R & D plaza. 20 Ramsay Road. Box 702. Shirley, New York, U.S.A. 11967-0702 Fig. (1).

Fig. (1): The biodex unweighting system.

5- Tilting Board

It consists of 2 parts : the ankle disk and a hemiball. The ankle disk diameter is 350 mm and it is centered on 75cm. diameter ball (wooden half sphere). The tilting board was used for the proprioceptive training.

Procedures

When the subjects came to the laboratory they received a full explanation of the procedures and the purpose of the study, then they signed an informed consent form.

Assessment

Pre Treatment

a) Assessment of pain by visual analog scale:

Marked pain was produced on the lateral ligaments. It was rated on 10 point scale defining (0) as no pain and (10) as the highest tolerable pain.

b) Assessment of swelling by figure-of-eight method:

Each subject was seated comfortably in a long sitting position with both feet extended beyond the end of the plinth to the level of the midcalf. The tested leg was slightly flexed over a pellow with a diameter of 15 cm. The tested ankle was maintained in a neutral dorsiflexion position as it was measured using the figure-of-eight. The data of measurements were recorded.

The tape measure was wrapped around the ankle along the following course.

1- The beginning of the tape was placed mid way between the tibialis anterior tendon and the lateral malleolus.
2- The tape was drown medially across the instep and placed just distal to the tuberosity of the navicular.
3- The tape was pulled across the arch and up, just proximal to the base of the 5th metatarsal.
4- The tape was pulled across the tibialis anterior tendon.
5- The tape was continued around the ankle joint just distal to the distal tip of the medial malleolus.
6- The tape was pulled across the achilles tendon.
7- The tape was placed just distal to the distal tip of the lateral malleolus, and
8- The measurement was ended at the start of the tape.

The procedure was performed three times for each foot, the injured and the normal, and the mean was taken and recorded.

c) Manual physical examination:

Manual tests for stability of lateral collateral ligaments to ensure that all subjects are grade I and II injury.

1- Anterior drawer test.
2- Inversion stress test.

d) Range of Motion (ROM):

A standard manual goniometer was used to measure the active. Range of motion of the ankle joint. Range of motion was measured for plantar flexion, dorsiflexion, Inversion and eversion.

Treatment program:

a) Acute phase, the first 72 hours from the time of the injury.

Both groups received intially this treatment protocol which include:

I- Ice application 5 minutes 3 times /day.
II- Elevation Immediately following Injury and evaluation " the leg was elevated above the level of the heart".
III- Elastic bandage was applied.
IV- Rest at bed (he can walk non weight bearing for toilet activity with crutches).
V- While the patient was elevating his leg , he was moving his leg in planter and dorsi flexion to the limit of pain.

b) Treatment program in subacute phase for group I (Traditional program) was:

All exercises from seated position with elastic ankle support and with partial weight bearing ie. The patient can walk on cane.

I- Active range of motion exercises (dorsiflexion, plantarflexion, eversion).
II- Curl and pick-ups (using tissue paper) in the sitting position.
III- Isometric exercises for dorsi flexion, plantar flexion and eversion.
IV- Seated balancing board (do dorsi flexion, plantar flexion and eversion) Figures (2 and 3).

Fig. (2): Seated Dorsiflexion.

Fig. (3): Seated Planter Flexion.

N.B.: The exercises were performed in sets each set included ten repetitions for 3 sets per day.

I- Passive streching for the tendo-acchilus hold 15 seconds and rest 15 seconds with 3 repetitions.

II- Partial squatting, the patient was asked to stand erectly and grasp the examination table, the patient was asked to flex the non involved leg with partial flexion and weight bearing on the involved leg and move downword for 3 repetitions.

c) After 3 weeks from the injury chronic phase treatment program was started.

I- Strengthing exercises, by using weight cuff in all directions dorsi flexion, plantar flexion and eversion for ten repetitions. Inversion will be repeated 3 repititions only.

II- Toe curl with resistnce.

III- Squatting from full weight bearing on both legs.

IV- Active streching exercises for the tendo-acchillus.

V- Endurance exercises (walk on toes, walk on heal and walk on lateral side of the foot).

VI- Proprioceptive exercises.

1. Single leg stand with eyes opened on even surface.
2. Single leg stand with eyes closed on even surface.
3. Standing single leg stance on a tilting board.
4. Standing single leg stance on a tilting board while performing a functional activity by the hand of the same affected side.

Graduated walking program starting by walking 200 meters up to 5000 meters.

VII- Graduated running program, started by 200 meters up to the patient's tolerance after that run in zigzag and figure of 8 patterns.

* Treatment program in subacute and chronic phases for group II after 3 days.

The same as group I but all activities from standing position with partial weight bearing using the unloading technique.

1- Harness supported started with caliberation of the body weight of the patient every session from 0% grade Fig. (4).

Fig. (4): Calibration of the patien's weight.

2- We started with 90% support bilatrally the amount of body weight support was decreased 10% every session, till we reached full weight bearing. These percentage was to enable the patient to perform program of treatment without pain and comfortablly (the decision to decrease body weight support was based on the ability of patient to do the exercises with the involved leg with quality and without pain.

3- The rehabilitation program was carried out closed kinetic chain.

- First session with 90% body weight support.

(1) Toe curl (using tissue paper) in standing position.
(2) Squatting on both legs.
(3) Active streching exercise for the tendoacchillus.
(4) Endurance exercises (walk on toes, walk on heal and walk on lateral side fo the foot).
(5) Proprioceptive exercises.

1. Single leg stand with eyes opened on even surface.
2. Single leg stand with eyes closed on even surface.
3. Standing single leg stance on tilling board.
4. Standing single leg stance on a tiling board while performing functional activities by the same side of the hand Fig. (5).
5. Graduated walking program was started by walking 200 meters up to 5000 meters or to patient tolerance Fig. (6).
6. Graduated running program started by 200 meters up to the patient's tolerance after that run in zigzage and figure of 8 patterns.

- By the end of the first session , the patients had tolerated an increase in load of 20% in all activity. By the end of 4 weeks all activities were performed with full body weight.
- After the completion of the 12 weeks program. We reassessed the patients using the intial evaluation procedures.

Fig. (5): Proprioceptive exercise with body weight support.

Fig. (6): Walking with body weight support.

Post trteatment assessment

After 12 weeks both groups were tested for:

1. Pain.
2. Swelling.
3. Manual physical examination.
4. Range of Motion.

Data Analysis

The results of the two groups were statistically analyzed to compare the difference with in each group and the differences between the two groups using chi square test to compare and analyze the results of the sex. Variables studied were summarized using the number of cases, mean, standard deviation, standard error, and level of confedence. Comparison of 2 means was done by unpaired t-test to compare between the same group before and after the treatment and paired t-test to compare between both groups before and after the treatment.

RESULTS

The analysis of pre treatment scores of both groups for the subjective and objective parameters showed no significant differences in all parameters except in the dorsi and planter flexion.

Table (1): Comparison between both groups before treatment in all variables pain, swelling and range of motion.

Group		N	SD	SE	P-value of the test
Pain	Group 1	20	0.858	0.l9l	0.852
	Group 2	20	0.825	0.l84	
Swelling	Group 1	20	0.488	0.1091	0.758
	Group 2	20	0.529	0.118	
Dorniflex	Group 1	20	l.82	0.407	.04
	Group 2	20	2.6	0.591	
Plantar flexion	Group 1	20	3.63	0.8126	.04
	Group 2	20	2.84	0.636	
Eversion	Group 1	20	1.66	0.373	0.32
	Group 2	20	2.033	0.454	
Inverstion	Group 1	20	1.68	0.37	0.05
	Group 2	20	3.138	0.701	

* SD : Standard Deviation.
* SE : Standard Error.

By using paired t-test for both groups after the treatment there was no significant difference between both groups after the treatment while there was significant difference between both groups at pain.

Table (2): Comparison between both groups after treatment (P>0.05).

Variables	P value
Pain	.002
Swelling	0.122
Dorsiflexion	0.794
Planterflexion	0.312
Eversion	0.409
Inversion	0.836

Comparison of both means for the both groups in all variables every week from 0 to 12th week was done and showed that the new method of treatment i.e. group II had rapid improvement. There was disappearance of pain and swelling by the 6th week and also returned to normal range of motion.

DISCUSSION

This study strongly proved the effectiveness of early weight bearing program with the unloading device as a method of treatment following ankle sprains, the analysis of mean of the pretreatment values of pain, swelling and range of motion showed a significant difference along the 12 weeks of treatment. This was supported by the findings of (Kern-Steiner et al., 1999)[18] that,

1- Unloading program provides a conceptual approach for progression of exercise that is relevant to a broad variety of musculskeletal injuries.
2- This program reduced the treatment duration required for return to full pain-free function.

There is a study made by El-Nahass (2000)[11], to assess the effect of early use of unloading program with inversion ankle sprain in acute stage showed that there was significant improvement in all subjects and they returned to normal functional activities and pain free walking. This study supported our work specially there was an increase in the range of motion of dorsiflexion by 21%, and the planterflexion by 2% also the inversion by 21% and the eversion by 69%. The strength of the affected side increased of dorsiflexors by 14%, the planterflexors by 24%, the invertors by 96% and the evertors by 34%.

Berg et al. (1993)[2] stated that lack of weight bearing or disuse is associated with atrophy and deteriorated function of skeletal muscle. Different human models of muscle unloading eg. cast immobilization following trauma or surgery, bed rest or weightlessness

have shown decreases in muscle mass or strength. Dudley et al. (1992)[7] reported that after 4-6 weeks of immobilization due to acute lesion of the medial collateral ligament there was a decreased in maximal corrected integrated electromyography (EMG) of vastus lateralis muscle. This may be due to reduced ability to activate high-threshold motor units muscle atrophy, an increase in resting membrane potential, or reduction in maximal firing frequency and/or a reduction in maximal firing frequency and/or a reduction in action potential amplitude which have been observed after disease in humans and lower mamals. Magnetic reasonance imaging (MRI) also appeared ankle extansor muscle group was 18% smaller than the nonaffected leg. Dietze, et al. (2002)[6] stressed that cyclical leg movement only in combination with loading of the legs lead to an appropriate leg muscle activation. Therefore it is not surprising that body unloading and reloading plays an essential role in the success of the locomotor training. Dietz and Colombo (1994)[5] reported that successive reloading during the training serve as a stimulus for the extensor load receptors. Glasoe et al. (1999)[14] stated that early weight bearing following grade II lateral ankle sprain injury can improve the healing and strength of damaged ligaments by increasing collagen formation and reducing adhesions, improve tissue nutrition, minimize muscle waisting and minimal loss of strength.

The results of post-treatment including t-test revealed that early weight bearing group was significantly better than the traditional group of treatment in pain, this gives an importance to the early weight bearing exercises as early as possible because the pain is the first thing which prevents the patient from doing his full duty and activity. These results suggest that the early weight a period of 4 weeks of wieght bearing was sufficent to cause this differnce in results. These results suggest that early weight bearing treatment is the treatment of choice for grade I and II ankle sprains, this program is opposite to most of the treatment programs used now adays which suggests casting for a period for 3 weeks incontrast in our study there were patients by the end of 4th or 5th weeks the pain and swelling disappeared and returned to normal range of motion.

Analysis of the results of post-treatment t-test for swelling revealed that no significance difference between both groups . But analysis of means every week showed there were disappearance in swelling in group II by 6th week. This decrease in swelling can be attributed to both the Initial RICE program (rest, ice, compression and elevation). The difference between the early weight bearing and the traditional program group can be attributed to the delay in the weight bearing between the two groups. This can be explained by the effect of early weight bearing exercise program on strengthening of the muscles around the ankle joint. This improves the circulation around the anklt joint. The disappearance of swelling in the early weight bearing group by the 6th week may also be one cause of the improvement in the range of motion in this group more early than the traditional group of treatment. Analysis of the results of post-treatment t-test for range of motion revealed that no significance difference between both groups. This provide an objective information as regarding to the response of both groups to the functional rehabilitation programs suggested and due to also increase in the range of motion of the uninvolved lege of the group II. The difference it was in the analysis of means every week showed that there were return to normal range of motion in group II by the 5th week. This may be attributed to the early disappearance of pain and swelling which prevents the patient to move his ankle and due to increase neural pathway. Tissue responds adequately to the stresses placed on it up to a certain point. Our bodies are amazingly adaptable and plastic, but all tissue has a point of fatigue: an amount of stress that when exceeded causes damage and eventually pain. In rehabilitation our goal is to stimulate tissue and to heal and gain both strength and endurance to allow maximal loading during every day activities and recreation. The results of the present study suggested that early weight bearing with body weight support maximizes patient's recoveries from ankle sprains and can save the time, costs and efforts of rehabilitation. The program can overcome the problems following ankle

sprains. The findings of this study and the results of uninvolved leg can be used in designing a program of exercises used with body weight support to improve function of lower limbs in atheletes because any ankle problem may contribute to the phenomena of poor weight acceptance for instance pain and any previous ankle injury may lead to decrease ankle range of motion. The new method of treatment also saves the time of casting program which was used for a long time, in addition this study proves that the disadventages of the casting and non weight bearing programs are more than the adventages. Such programs inspite of assisting healing, they can be a cause of instability that may take long time to be treated such instability if persisted may be the end of the sportives activities in athletes.The mechanical reduction of gravitational force on the body while performing functional activities during weight bearing excercises allows exact control over the amount of stress to the lower extremities, so this program could be used as part of designed preventive strategy. The incremental gradual increase of weight bearing on lower extremities during training provided an easy tolerable transition to full weight bearing activities. The suggested program of treatment provided both motiviation and confidence, through the early intervention and the mechanical reduction of the gravitational force. Both factors increased the effectiveness and decreased the duration of time of the patient's to return normal.

Concluion and Recommendations

The following recommendations were concluded from this study.

1- It is recommended that this treatment be implemented early during acute rehabilitation and continued through out the community based rehabilitation process to promote a more efficient results.
2- Simlar study is needed to explain the effects of early weight bearing with body weight support in a larger groups of subject, stratified according to the degree of injury and other ligamentous injury of lower limbs to determine which subjects would respond more favourably to this approach of treatment.
3- The effects of supporting varying levels of body weight support from 10 % to 100% also need to be investigated. This would help to define the criteria by which body weight support should be decreased during training.
4- It is suggested that the new method of rehabilitation could be used as an integral part of lower limb injuries treatment programs.
5- A long term follow up study is recommended to observe the percentage of recurrence of the inversion ankle sprain in these patients.

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الملخص العربى

دراسة مقارنة بين التحميل المبكر وبرنامج العلاج الطبيعي التقليدي في علاج التواء مفصل الكاحل

يهدف هذا البحث لدراسة تأثير برنامج العلاج التقليدى بالمقارنة مع برنامج التحميل المبكر فى علاج إصابة الأربطة الوحشية لمفصل الكاحل فى خلال 48 ساعة من الإصابة . تقييم قبل العلاج ثم بعد 12 أسبوع من العلاج تقييم متأخر من برنامجى العلاج وقد اشترك فى هذه الدراسة أربعون متطوع تتراوح أعمارهم بين 19 – 38 عاماً . وقد تم تقسيمهم الى مجموعتين عشوائيا وتلقت المجموعة الاولى برنامج العلاج التقليدى والمجموعة الثانية برنامج التحميل المبكر . أشارت نتائج البحث الى وجود فروق معنوية بين برنامج التحميل المبكر والعلاج التقليدى فى الألم وإختلاف كبير بين المجموعتين فى استعادة المدى الحركى الطبيعى واختفاء الورم الناتج من الإصابة لصالح مجموعة التحميل المبكر ، مما يدل على نجاح برنامج التحميل المبكر .

الكلمات الدالة : مفصل الكاحل ، الأربطة الوحشية ، برنامج التحميل المبكر ، برنامج العلاج التقليدى .